INDIANA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS MANAGEMENT

DRY UNIT WEIGHT
OF
FLOWABLE BACKFILL
ITM No. 218-15T

1.0   SCOPE.

   1.1   This test method covers the procedures for sampling and measuring the dry unit weight of flowable backfill.

   1.2   This ITM may involve hazardous materials, operations, and equipment and may not address all of the safety problems associated with the use of the test method. The user of the ITM is responsible for establishing appropriate safety and health practices and determining the applicability of regulatory limitations prior to use.

2.0   REFERENCES.

   2.1   ASTM Standards.

   D 5971   Sampling Freshly Mixed Controlled Low-Strength Material

   2.2   AASHTO Standards.

   M 231   Weighing Devices Used in the Testing of Materials

3.0   TERMINOLOGY. Definitions for terms and abbreviations shall be in accordance with the Department's Standard Specifications, Section 101.

4.0   SIGNIFICANCE AND USE. This ITM is used to sample, mold, cure, transport, prepare, and measure the dry unit weight of flowable backfill.

5.0   APPARATUS.

   5.1   Cylinder molds, 6 in. by 12 in. plastic with a 0.125 in. diameter hole drilled in the center of the bottom of the mold. Tape shall be used to cover the hole drilled in the bottom of the cylinder.

   5.2   Compressed air source, with a load of 30 ± 10 psi and a nozzle opening of 0.5 in. ± 0.125 in.

   5.3   Oven, with at least 1.75 ft^3 capacity and capable of maintaining a temperature at $221 \pm 9°F$

5.4   Balance, Class G2, conforming to the requirements of AASHTO M 231

5.5   Calipers, readable to 0.001 in.

5.6   Storage container, for storage of the cylinder at the construction site, equipped as necessary to maintain the temperature immediately adjacent to the cylinder in the range of 60 to 80°F

5.7   Scoop or bucket

5.8   Plastic bag or domed plastic lid

5.9   Burlap or other highly absorbent material

5.10   Curing Environment, a moist closet, moist room, or enclosed curing tank above water level

6.0   **SAMPLING.** Sampling of the flowable backfill shall be in accordance with ASTM D 5971.

7.0   **PREPARATION OF TEST SPECIMEN.**   One cylinder specimen is required to determine the dry unit weight. Measurements of the specimen diameter, height, and weight shall be used to determine the dry unit weight.

7.1   **Molding.** The procedures for molding the specimen shall be as follows:

7.1.1   Place the mold on a level, rigid, horizontal surface free from vibration and other disturbances. The location of molding shall be at a place as near as practicable to the location where the mold is to be stored during the initial curing.

7.1.2   Thoroughly mix the flowable backfill in the sampling and mixing container

7.1.3 Scoop through the center portion of the container with a bucket and pour the flowable backfill into the cylinder mold. Repeat this procedure until the mold is filled (Note 1).

Note 1: Some mixtures will have free water in the mold after filling. If free water is standing in the mold, thoroughly mix the remaining mixture in the sampling container and place a scoopfull of mixture in the mold to displace the water. Additional filling may be required after approximately 15 minutes. If possible, a slight round of mixture should be left on the top of the mold.

7.1.4 Place a plastic bag over the top of the cylinder mold and secure the bag to the mold. A domed plastic lid may be used.

7.2 **Curing.**

7.2.1 Store the specimen at the construction site in the storage container until the fourth day after preparation. The cylinder shall be stored under conditions that maintain the temperature immediately adjacent to the cylinder in the range of 60 to 80°F.

7.2.2 After the first day, surround the cylinder with wet burlap or highly absorbent material

7.2.3 On the fourth day, carefully transport the cylinder in the storage container to the site of the curing environment

7.2.4 Cure the specimen in the curing environment for the remainder of the total 14 day curing period. The specimen shall be kept in the mold during the curing period.

7.3 **Specimen Mold Removal.** The specimen mold shall be removed carefully so as not to damage the sample prior to testing. Two operators may be required to safely remove the specimen from the mold. The procedure for removing the mold shall be as follows:

7.3.1 Remove the tape from the bottom of the sample mold

7.3.2 Place the nozzle of the compressed air source at the bottom of the specimen at the location of the drilled hole

7.3.3 Use the compressed air to slowly force the specimen out of the cylinder mold

7.3.4 Saw the ends of the specimen, if necessary, to create a plane surface that is perpendicular to the axis of the cylinder

7.3.5 Place the specimen in a pan and place the pan in an oven at $221 \pm 9°F$ for 24 h. Weigh the pan and specimen to the nearest 0.01 lbm. Continue drying and weighing the pan and specimen at 1h intervals until constant weight (Note 2) is obtained.

Note 2: Constant weight is defined as the weight at which further drying at the required drying temperature does not alter the weight by more than 1 %.

7.3.6 Cool the specimen to room temperature

7.3.7 Record the weight (W) of the specimen to the nearest 0.01 lbm

7.3.8 Measure the diameter (D) of the specimen in three different locations, D_1, D_2, and D_3 along the length of the specimen and record the diameter measurements to the nearest 0.001 in.

7.3.9 Measure the height (H) of the specimen in three different locations, H_1. H_2, H_3, and record the height measurements to the nearest 0.001 in.

8.0   CALCULATIONS.

8.1   Calculate the average diameter of the specimen as follows:

$$D, \text{in.} = \frac{D_1 + D_2 + D_3}{3}$$

where:
    D = average diameter, in.
    D_1 = diameter at the first location, in.
    D_2 = diameter at the second location, in.
    D_3 = diameter at the third location, in.

8.2   Calculate the average height of the specimen as follows:

$$H, \text{in.} = \frac{H_1 + H_2 + H_3}{3}$$

where:
    H = average height, in.
    H_1 = height at the first location, in.
    H_2 = height at the second location, in.
    H_3 = height at the third location, in.

8.3   Calculate the volume of the specimen to the nearest 0.01 ft^3 as follows:

English

$$V, ft^3 = \left[3.1416 \times \left(\frac{D}{2} \right)^2 \times H \right] / 1728$$

where:
  V = volume of specimen, ft^3
  D = average diameter, in.
  H = average height, in.

8.4   Calculate the dry unit weight to the nearest 0.1 lb/ft^3 as follows:

$$U_w, \ lb/ft^3 \ = \ \frac{W}{V}$$

where:
  U_w = dry unit weight, lb/ft^3
  W = weight of the specimen, lb
  V = volume of specimen, ft^3

9.0   **REPORT.** The dry unit weight of the specimen is reported in lb/ft^3